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Sources of Agricultural Growth in India: Role of Diversification towards High-Value Crops

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ABSTRACT

This study examines the sources of crop income growth in Indian agriculture over the 1980s and 1990s. Using a method developed by Minot (2003), the analysis decomposes crop income growth into the contribution of yield increases, area expansion, price increases, and diversification from low-value crops to higher-value crops. The results confirm that at the national level, technology (higher yield) was the main source of crop income growth during 1980s, while rising prices and diversification emerged as the dominant sources of growth in agriculture during 1990s. Diversification towards higher-value crops such as fruits and vegetables accounted for about 27% of crop income growth in the 1980s and 31% in the 1990s. However, these national averages hide substantial regional variation. In the grain-dominated northern and eastern regions, price increases were the most important source of growth during 1990s, while in the southern and western regions crop income growth was led by diversification into higher-value crops. The results reflect the slowing growth of wheat and rice yields in India, as well as the growing importance of diversification into higher-value crops. Restoring the growth in grain yields will require investment in agricultural research and development, while facilitating further diversification involves institutional development to better link small farmers with growing markets for high-value commodities.

SOURCES OF AGRICULTURAL GROWTH IN INDIA: ROLE OF DIVERSIFICATION TOWARDS HIGH-VALUE CROPS

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1. INTRODUCTION

Indian agriculture has witnessed an impressive trajectory from a food deficit country to food self-sufficiency and finally to a food surplus country. Foodgrain production rose from 74 million tons in 1966-67 to 213 million tons in 2001-02 (Government of India 2004). Such a remarkable transformation from food deficits to surpluses was a result of rapid adoption of advanced technologies, massive investment in infrastructure (including irrigation, markets, and roads), creation of appropriate institutions (including extension services and credit), and policy support (Evenson et al. 1999).

However, the agricultural sector is now at the crossroad with numerous problems and opportunities. Agricultural growth has decelerated from 3.2 percent a year between 1980-81 and 1995-96 to 1.8 percent between 1996-97 and 2001-02 (Chand 2004). The Green Revolution technologies that contributed increased foodgrain production have reached a plateau, and the growth in crop yields and total factor productivity has slowed down and, in some cases, stagnated (Evenson et al, 1999; Murgai *et al.*, 2001 and Sidhu, 2002). Policies left over from the period of foodgrain deficits persist, blocking growth

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opportunities. Furthermore, rising population pressure is squeezing agricultural land for cultivation and pastures. Finally, the agricultural sector is under significant adjustment pressure related to market liberalization and globalization. The National Agricultural Policy (NAP), 2000 targeted a growth rate exceeding 4 percent per annum in agriculture sector (Government of India 2002). It envisaged a technology-led and demand-driven growth to benefit widespread rural population and sustain soil and water resources. Unfortunately, the targets could not be achieved for various reasons, including the slow pace of reform in agriculture sector and consecutive droughts in different parts of the country. For example, the growth in agriculture sector was mere 0.7 percent in 2004-05 due to deficient rainfall but increased to 2.3 percent in 2005-06, which is much below than the targeted growth rate (Government of India 2006). To accelerate the pace of agricultural growth, it is important to better understand past sources of growth in the agricultural sector.

The present study attempts to identify and quantify the relative contribution of different sources of agricultural growth in India over recent decades. A better understanding of different sources of growth and their magnitude would provide empirical support for the design of policies to accelerate the pace of agricultural growth. The specific objectives of the study are to: (i) quantify the changes in the relative contribution of different sources of agricultural growth during the past two decades, (ii) examine the regional differences, if any, in the sources of agricultural growth, and (iii) suggest appropriate policies for accelerating agricultural growth in different regions. We hypothesize that agricultural diversification towards high-value crops and output prices

were the important sources of growth in agriculture during the decade of 1990s, the period of economic reform.

The study is confined to the crop sector, which dominates the agricultural sector. Crop production represented 72 percent of the agricultural gross domestic product in TE⁵ 1999-2000, which represents only a slight decline from the 74 percent share in TE 1981-82 (Table 1). From the late 1960s to the early 1980s, the Indian agricultural sector underwent the Green Revolution, characterized by widespread adoption of improved varieties of rice and wheat that substantially increased yields and consequently production. The impact of Green Revolution in the crop sector started fading in the 1980s, with yield growth slowing significantly.

The paper is organized into five sections. After providing a brief background of the study in the first section, we describe analytical framework and data sources in the second section. The following sections describe the sources of agricultural growth at national and regional levels. We conclude by discussion the implications for the design of policies for accelerating agricultural growth.

Table 1—Share of different sectors in agricultural gross domestic product, India (1980-81 prices).

Item	TE 1981-82	TE 1991-92	TE 1999-2000
Share of agriculture in GDP (%)	39.7	32.8	26.3
Share of different sectors in agricultural GDP (%)			
Crops	73.7	72.0	71.4
Livestock	19.2	22.2	22.9
Fishery	2.0	2.5	3.0
Forestry	5.1	3.2	2.7
Total	100.0	100.0	100.0

Source: Government of India, 2005 and 2006.

⁵ TE 1999-2000 refers to the average for the triennium (three-year period) ending in 1999-2000.

2. DATA AND METHODS

This study covers the two decades from 1980-81 to 1999-2000. We divide this period into two parts: 1980-81 to 1990-91 and 1991-92 to 1999-2000. There are two reasons for studying these two decades separately. First, the impact of the Green Revolution was fading in different parts of India during the 1980s. Second, a series of economic reforms, including liberalization of agricultural markets, was launched starting in 1991. Since the decade of 1990s represents a period of economic reforms, a comparison of results of these two periods would provide an insight into the changes in sources of agricultural growth as a result of agricultural reform.

REGIONAL DIFFERENCES

There is considerable heterogeneity in crop composition and their performance in different parts of India. Therefore, the study examines the sources of growth at national as well as regional levels. Five regions have been delineated based on socio-economic and agro-climatic characteristics: (i) northern, (ii) eastern, (iii) western, (iv) southern, and (v) northeastern⁶. Due to paucity of information, the study does not analyze sources of growth in the northeastern region.

Most states in each region are relatively homogeneous in agro-climatic characteristics, crop composition and agricultural productivity, although they are

⁶ Northern region includes Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Uttaranchal and Uttar Pradesh; Eastern region comprises Bihar, Jharkhand, Orissa and West Bengal; Southern region consists of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu; Western region includes Chattishgarh, Gujarat, Goa, Madhya Pradesh, Maharashtra and Rajasthan; and Northeast region comprises Assam, Arunchal Pradesh, Meghalaya, Manipur, Nagaland, Sikkim and Tripura.

heterogeneous in infrastructure and other socioeconomic characteristics. With exception of hill states, most states in the northern region have alluvial soils and a similar rainfall pattern. The climate is semi-arid, but the share of agricultural land that is irrigated is high. Rice and wheat are most important crops in most states except in the hills where maize, wheat and fruits and vegetables dominate.

States in the eastern region have alluvial soils, a humid climate and low levels of irrigation (except in West Bengal). Rice is a major crop everywhere. Vegetables are also grown widely in all states. Rice yield is similar across states except in West Bengal where it is higher.

The states in the southern region have a similar rainfall pattern, except in coastal zone, and agriculture is largely rainfed. Rice is the main crop everywhere and its yield does not show any significant variation except Tamil Nadu where it is higher.

The states in the western region have low rainfall but not much difference in normal rainfall. The irrigation levels are low and do not vary much among states. The cropping pattern is diversified. Rice, wheat, sorghum and pearl millet are important crops with almost similar yield levels. Many important fruits like pomegranate, grapes, and guava are cultivated in the western states.

DATA SOURCES

State-level data on area, production and yield of different crops were compiled from various issues of the *Indian Agricultural Statistics* published by the Government of India. The value of production of different crops was compiled from the *Value of Output of Crop Sector* published by the Central Statistical Organization (CSO). The other sources

included *National Accounts Statistics* published by the Government of India, and the *Statistical Abstracts* published by different state governments. The published data was supplemented by some unpublished data obtained from the Central Statistical Organization. The state-level data were then aggregated to the four regions described above.

METHOD OF DECOMPOSITION OF AGRICULTURAL GROWTH

Changes in the gross income⁷ from a *single* crop can be decomposed into changes in sown area, changes in yield, changes in price, and a residual that represents the interaction of these three sources of growth. Changes in the gross income of *total* crop production can be similarly decomposed, except that there is an fourth source of growth: changes in the crop mix toward higher-value crops. A key contribution of this paper is estimating the contribution of diversification into higher-value crops to the growth in crop income in India.

Each of these sources of growth is, in turn, influenced by various policy and non-policy factors. For example, changes in total crop area reflect changes in weather, population growth, and migration, among other trends. Yields are affected by the introduction of new varieties, changes in the location of crop production, irrigation investment, and rainfall. Prices are be influenced by trade policy and world prices (in the case of tradable crops), shifts in domestic supply and demand (in the case of non-tradables), agricultural price policy, and other variables. Finally, the share of land

⁷ We define gross income from crop production as the value of crop production. Since some output is not marketed, this concept includes both cash and in-kind income.

allocated to each crop is influenced by relative prices, input costs, extension programs, and other factors.

We calculate the contribution of area, yield, prices, and diversification to the growth in gross crop income using the method described by Minot (2003). If A_i is the area under crop i , Y_i is its production per unit area, and P_i is the real price per unit of production, then the gross income or revenue (R) from producing n crops is:

$$R = \sum_{i=1}^n A_i Y_i P_i \quad (1)$$

Expressing A_i as share of crop i in the total cropped area, $a_i = (A_i / \sum_i A_i)$, equation (1) can be rewritten as:

$$R = \left(\sum_{i=1}^n a_i Y_i P_i \right) \sum_{i=1}^n A_i \quad (2)$$

To measure the change in gross crop income, we take total derivatives of both sides of equation (2), yielding:

$$dR \cong \left(\sum_{i=1}^n a_i Y_i P_i \right) d \left(\sum_{i=1}^n A_i \right) + \left(\sum_{i=1}^n A_i \right) d \left(\sum_{i=1}^n a_i Y_i P_i \right) \quad (3)$$

This equation holds only approximately because it excludes the interaction term⁸. The second term on the right-hand side of equation (3) can be further decomposed from a change in sums to the sum of changes, as follows:

$$dR \cong \left(\sum_{i=1}^n a_i Y_i P_i \right) d \left(\sum_{i=1}^n A_i \right) + \sum_{i=1}^n A_i \sum_{i=1}^n d(a_i Y_i P_i) \quad (4)$$

⁸ To take a simple example, if area increases 20 percent and yield increases 20 percent, total output expands by 44 percent ($1.2 \times 1.2 = 1.44$). Area contributed 20 percentage points, yield contributed 20 percentage points, and the remaining 4 percentage points represent the interaction of area and yield changes.

Further expansion of the second term in equation (4) gives the following expression:

$$dR \cong \left(\sum_{i=1}^n a_i Y_i P_i \right) d \left(\sum_{i=1}^n A_i \right) + \sum_{i=1}^n A_i \sum_{i=1}^n a_i Y_i dP_i + \sum_{i=1}^n A_i \sum_{i=1}^n (a_i P_i dY_i) + \sum_{i=1}^n A_i \sum_{i=1}^n (Y_i P_i da_i) \quad (5)$$

The first term on the right-hand side of equation (5) denotes the change in the gross crop income due to changes in total cropped area. The second term gives the effect of changes in real prices. The third term captures the effect of change in crop yields. And the fourth term describes the change in gross crop income associated with changes in the area composition of crops over time. If the fourth term is positive, this indicates a reallocation of cropland from lower-value crops to higher-value crops, so this term represents the effect of crop diversification on gross crop income. Dividing both sides of equation (5) by the overall change in gross crop income (dR) gives the proportional contribution of each component in the growth.

The pattern in the sources of growth has implications for the agricultural development policies (Minot, 2003). For example, if a large share of the growth in crop income is associated with area expansion, this may reflect an unsustainable trend, particularly if arable land is limited. Similarly, a pattern in which much of the growth is related to price increases may reflect changes in policy or reduced transportation costs, but it is probably not sustainable in the long run. In either case, the implication is that greater efforts should be made to improve yields and help farmers diversify into higher-value crops. The policy implications of the contribution of yield increases and diversification are less obvious. Does a small contribution indicate that there is under-investment in that type

of growth, calling for greater effort? Or does a small contribution mean that economic conditions do not favor that type of growth, implying that public investment should be correspondingly small? We return to these issues in the concluding section of the paper.

3. SOURCES OF GROWTH IN AGRICULTURE AT NATIONAL LEVEL

At the national level, the crop sector is dominated by rice, wheat, fruits and vegetables, and oilseeds (Table 2). These crops together accounted for about 71 percent of the total value of crop output in TE 1999-2000. Over time, the production-mix changed to meet the market demand and also availability of new technology. For example, the share of fruits and vegetables in total value of crop output increased significantly from 14 percent in TE 1981-82 to 21 percent in TE 1999-2000. On the other hand, the shares of rice, pulses and oilseeds declined somewhat during this period.

Table 2—Share of different commodities in the gross value of crop output and annual compound growth rates in India

Crop	Share in the gross value of crop output* (%)			Annual compound growth rate (%)		Share in annual growth rate (%)	
	TE 1982-83	TE 1991-92	TE 1999- 2000	1980s	1990s	1980s	1990s
Rice	25.6	23.3	23.7	2.9	2.9	21.3	21.5
Wheat	14.6	12.6	15.0	1.9	5.8	6.8	22.2
Coarse cereals	9.2	6.4	5.2	-0.8	1.0	-1.6	2.1
Pulses	6.7	6.3	5.6	5.2	1.9	7.9	1.5
Oilseeds	13.2	15.5	11.7	5.7	0.6	20.4	1.8
Fibers	4.4	4.4	3.3	3.6	-0.5	5.0	-0.4
Sugarcane	8.0	7.2	8.0	3.8	4.9	7.0	8.8
Beverage crops	1.2	1.2	1.2	3.1	1.8	2.7	2.6
Fruits and vegetables	13.7	18.6	20.5	4.6	6.2	23.7	32.1
Spices	2.4	3.6	4.5	8.6	6.8	6.4	7.6
Other crops	1.0	1.0	1.3	1.0	8.8	0.4	0.4
All crops	100.0	100.0	100.0	3.5	3.6	100.0	100.0

*Gross values do not include the value of crop byproducts (straws and stovers). Values are three years averages of displayed ending year.

Source: Government of India (various years). *Value of Output of Crop Sector*.

The crop sector was growing at an annual rate of 3.5 percent during 1980s and 3.6 percent during 1990s (see Table 2). The output of spices and of fruits and vegetables grew rapidly (over 4.5 percent) in both decades, reflecting diversification into higher-value crops. Oilseed output expanded at over 5 percent per year in the 1980s, but annual growth fell to less than 1 percent in the 1990s. In contrast, the value of wheat output grew slowly (barely 2 percent per year) in the 1980s but accelerated to almost 6 percent per year in the 1990s.

The last two columns of Table 2 present the contribution of each crop to the growth in total income from the crop sector. In the 1980s, rice, oilseeds, and fruits and vegetables each contributed over 20 percent of overall crop growth. In contrast, rice, wheat, and fruits and vegetables were the main sources of growth during the 1990s. These three commodity groups contributed three-quarters of the growth of crop sector, with fruits and vegetables alone accounting for almost one-third of the growth in crop production.

The most striking pattern in these results is that fruits and vegetables have emerged as the most important source of growth in crop sector despite their limited share in gross cropped area (5.1%). Their contribution in the growth of crop sector increased from 23.7 percent during 1980s to about 32.1 percent during 1990s. The growing importance of fruits and vegetables is a result of increasing demand for these commodities in the domestic markets and their growing exports, supported by the development of roads, markets and processing to link their production with consumption (Joshi et al 2004). Domestic demand for fruits and vegetables increased by 164 percent and 50 percent respectively in rural areas

between 1983 and 1999-2000. For urban areas, the increases were 184 and 39 percent during the same period (Kumar and Mruthyunjaya 2003). It is projected that per capita demand for these commodity groups will increase by 63 percent by 2015 while those of cereals will decline by 3.6 percent. At the same time, the export of fruits and vegetables rose from US\$ 101 million in 1980-81 to US\$ 120 million in 1990-91 and US\$ 513 million in 2003-04 (Government of India 2005).

Another important trend is the declining contribution of oilseeds and growing share of wheat during the decade of 1990s. The large contribution of oilseeds in crop income growth during the 1980s was due to the “Oilseed Mission,” a program launched in 1987 to stimulate production and achieve self-sufficiency in edible oils. A key element of this program was high non-tariff barriers on imported edible oils, the most important of which are palm oil and soybean oil. During 1990s, as a result of trade liberalization, large-scale oil imports resumed, leading to lower prices, stagnant oilseed production, and virtually no contribution of oilseeds to crop income growth. The area planted to oilseeds (mainly groundnuts and rapeseed-mustard), which had increased at an annual rate of 3.1 percent during 1980s, rose less than 1 percent per year during 1990s (Appendix I).

On the other hand, the substantial increase in the contribution of wheat to agriculture growth during 1990s is linked to its expansion in non-traditional areas mainly due to availability of new varieties and the minimum support price by the central government. In addition, in some parts of India, wheat competes with oilseeds, so the falling profitability of oilseeds led to substitution into wheat.

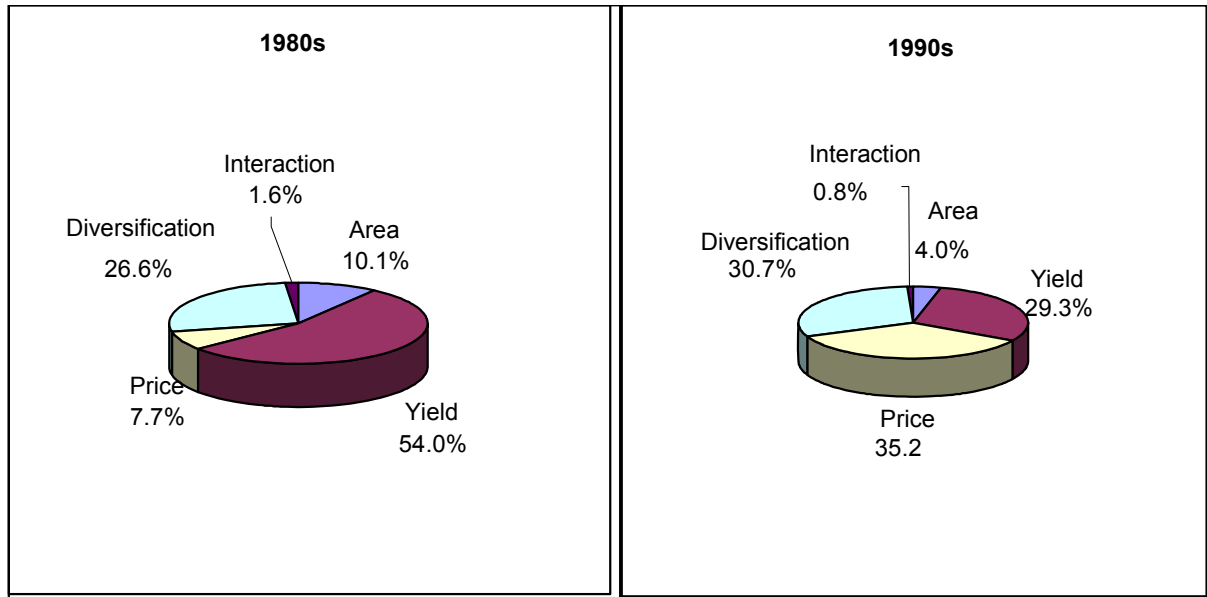
In Table 3 and Figure 1, we decompose the contribution of different sources of growth in crop value, namely total crop area, yield, prices and crop diversification, as explained earlier. The results suggest that the sources of growth have changed dramatically over the last two decades. During 1980s yield improvements made largest contribution to crop income growth, while in the 1990s rising real prices turned out to be the principal source of growth. The contribution of real prices in the growth jumped from 7.7 percent in the 1980s to 35.2 percent during 1990s, and that of yield declined from 54 percent to 29.3 percent during the same periods.

Table 3—Contribution of different sources of growth in crop sector, India (%)

Crop/crop groups	Area	Yield	Prices	Diversification	Interaction	All
During 1980s						
Rice	11.5	103.5	-26.5	11.3	0.3	100.0
Wheat	19.4	151.6	-56.7	-13.2	-1.1	100.0
Coarse cereals	-41.1	-223.6	130.2	225.1	9.4	100.0
Pulses	9.1	19.8	68.8	-2.8	5.0	100.0
Oilseeds	7.8	20.6	10.0	58.2	3.4	100.0
Fibers	9.0	105.6	4.8	-12.6	-6.9	100.0
Sugarcane	11.4	49.5	-3.0	41.2	0.9	100.0
Beverage crops	6.2	27.8	51.3	12.5	2.2	100.0
Fruits and vegetables	6.4	4.3	27.6	59.7	2.0	100.0
Spices	5.5	24.9	52.6	17.8	-0.8	100.0
Other crops	15.8	22.8	131.8	-177.8	107.5	100.0
Total	10.1	54.0	7.7	26.6	1.6	100.0
During 1990s						
Rice	4.5	39.5	48.2	6.8	1.0	100
Wheat	2.2	28.6	41.6	25.6	1.9	100
Coarse cereals	12.4	108.9	135.9	-158.1	0.8	100
Pulses	17.0	49.2	134.6	-107.3	6.5	100
Oilseeds	32.9	273.4	-388.9	193.7	-11.1	100
Fibers	-40.1	209.9	157.7	-251.9	24.5	100
Sugarcane	3.2	14.7	49.0	31.9	1.2	100
Beverage crops	2.1	46.2	29.6	19.8	2.2	100
Fruits and vegetables	2.4	7.4	30.6	58.8	0.8	100
Spices	1.6	37.5	41.7	19.3	-0.1	100
Other crops	8.7	-88.6	158.9	37.9	-16.9	100
Total	4.0	29.3	35.2	30.7	0.8	100

Source: Authors' calculations based on data from various years of *Indian Agricultural Statistics* and *Value of Output of Crop Sector*.

Figure 1—Share of different sources of growth in agriculture in India



Source: Authors' calculations based on data from various years of *Indian Agricultural Statistics* and *Value of Output of Crop Sector*

Since area expansion is limited, the contribution of crop area as a source of growth is diminishing. As noted above, rising prices were the most important source of crop income growth in the 1990s. The real prices of rice increased at an annual rate of 1.1 percent and those of wheat by 2.1 percent during the decade of 1990s (Appendix I). This is the reverse of the pattern during 1980s when the real prices of rice and wheat declined at an annual rate of 1.0 percent. With the exception of oilseeds, cotton, and beverages, the real domestic prices of all commodities grew faster during 1990s as compared to 1980s. Most of the foodgrains in India are covered under the government policy of 'Minimum Support Price' (MSP); consequently their prices were raised to protect the interests of the farmers to counter deceleration in their yield growth. In the case of perishable crops like fruits and vegetables, it was their growing demand and constrained supply that pushed up their prices.

Declining contribution of yield to crop income growth is due to the slowing of yield growth rates of most of the crops during 1990s as compared to 1980s (Appendix I). Sharp deceleration was noted in rice, wheat, cotton, and sugarcane. It is a clear indication of the fatigue in the existing technologies. This may suggest the need for greater investment in agricultural research and extension, which at present is only 0.4 percent of the agricultural gross domestic product (Pal 2005).

The contribution of diversification (crop substitution) to growth rose from 26.6 percent during 1980s to 30.7 percent during 1990s, indicating that the process of diversification from low-value crops to high-value crops was already important in the 1980s and became more so in the 1990s. In particular, the area under coarse cereals and pulses declined during the 1990s and the area under rice and oilseeds grew at less than 1 percent per year, while the area under fruits and vegetables grew at more than 4 percent per year during the decade (see Appendix I). Over the two decades, the share of fruits and vegetables in the total cropped area has increased from 2.8 percent in TE 1981-82 to 5.1 percent in TE 1999-2000. If these trends continue, it is likely that crop diversification will become the most important source of crop income growth in the near future.

In summary, during the 1980s, the last phase of the Green Revolution, technology-driven yield increases accounted for over half the growth in gross income from crops. In contrast, in the 1990s, a decade marked by a series of policy reforms to liberalize markets, the main sources of crop income growth were rising prices and diversification from low-value crops such as coarse cereals, pulses, and oilseeds toward higher-value crops such as fruits and vegetables.

4. REGIONAL PATTERNS OF SOURCES OF GROWTH

There is considerable spatial diversity in production portfolio across different regions in India mainly due to differences in agro-climatic conditions, infrastructure and socio-economic factors. This section examines the sources of growth in different regions. As stated earlier, we divide the country into the eastern, northern, southern and western regions. Salient characteristics of these regions are reported in Table 4, which clearly reveals wide variation across regions with respect to resource endowment and level of development.

The Northern region, including the state of Punjab, specializes in intensive grain production. Wheat is the most important crop in terms of area and value, followed by rice. Together they account for 62 percent of the cropped area and 56 percent of the value of crop output. Almost three-quarters of the cropped area is irrigated, compared to less than 40 percent in the other regions. The use of fertilizer in the Northern region is far above the national average and only slightly less than in the Southern region. The share of agriculture in GDP in this region (36.8 percent in TE 1999-2000) is higher than in the other regions.

The Eastern region is characterized by relatively high rainfall, widespread rice production, and a population density that is almost twice the national average. Rice accounts for almost 60 percent of the cropped area and 41 percent of the value of crop

Table 4—Selected characteristics of agriculture in different regions of India

Characteristics	Northern	Eastern	Western	Southern	All-India
Population (2001) in millions	236	253	286	222	1027
Population density (persons/ km ²)	283	498	179	309	257
Urban population, 2001 (%)	22.9	18.2	35.8	33.2	27.8
Per capita GDP, 1999-2000 (Rs at 1980-81 prices)	2610	2271	4140	3411	3144
Share of agriculture in GDP (%), 1980-81 prices					
TE 1982-83	49.7	37.4	36.4	36.8	39.7
TE 1991/92	42.8	33.0	27.9	30.6	32.8
TE 1999-2000	36.8	29.6	21.6	23.6	26.3
Gross cropped area irrigated, TE 1999-2000 (%)	74.1	32.1	28.2	37.4	40.2
Fertilizer consumption, TE 1999-2000 (kg/ha)	127.5	78.7	55.7	134.5	88.0
Share in gross cropped area, TE 1999-2000 (%)					
Rice	24.4	59.4	10.3	24.1	24.5
Wheat	38.1	8.6	12.6	0.8	15.6
Coarse cereals	10.4	3.8	24.2	18.1	16.6
Pulses	7.6	6.2	16.9	12.9	12.3
Oilseeds	5.1	4.8	20.9	22.4	14.9
Fibers	2.7	2.6	7.8	6.2	5.5
Sugarcane	5.2	0.7	1.2	2.7	2.4
Beverage crops	0.0	1.1	0	1.2	0.4
Fruits and vegetables	5.0	10.8	2.3	6.4	5.1
Spices	0.1	1.2	0.7	3.6	1.2
Other crops	1.4	0.8	3.1	1.6	1.5
Total	100.0	100.0	100.0	100.0	100.0
Share in value of crop output, TE 1999-2000 (%)					
Rice	21.7	41.5	9.5	26.7	23.7
Wheat	34.5	5.7	15.5	0.2	15.0
Coarse cereals	3.5	1.4	9.5	5.6	5.2
Pulses	4.5	2.5	11.1	3.3	5.6
Oilseeds	2.7	2.2	20.9	19.8	11.7
Fibers	1.9	1.6	6.2	2.9	3.3
Sugarcane	12.5	1.5	7.6	9.0	8.0
Beverage crops	0.0	4.3	0.0	1.1	1.2
Fruits and vegetables	18.2	35.3	15.0	16.4	20.5
Spices	0.4	3.8	3.4	11.2	4.5
Other crops	0.2	0.2	1.3	3.7	1.3
Total	100.0	100.0	100.0	100.0	100.0

Sources: Government of India (2004); Government of India (2005); and Government of India (various years).
Indian Agricultural Statistics.

output. Fruits and vegetables are the second most important crop category, accounting for 11 percent of the area and 35 percent of the value. However, less than a third of the total cropped area is irrigated (see Table 4).

The Western region is characterized by relatively low rainfall, low population density, and diversified rainfed production in which oilseeds (particularly groundnuts and rapeseed), wheat, and fruits and vegetables are the most important crop categories in terms of value. Coarse cereals, such as millet and maize, are the most widespread crops, accounting for almost one-quarter of the cropped area. Production tends to be less intensive, with less irrigation and lower fertilizer use per hectare than any other region. It is also the most urbanized of the four regions.

In the Southern region, rice is the most important crop in terms of value, followed by oilseeds, fruits and vegetables, and spices. Production is relatively intensive, with the highest fertilizer use and the second-highest share of irrigated land among the four regions (see Table 4).

The overall performance of agriculture sector (including livestock and fisheries) during 1990s was much better in the western region as compared agriculture-dominated northern region. It is, therefore, important to examine the sources of agricultural growth in different regions to understand the traditional and new growth sources to prescribe appropriate measures for accelerating the pace of agricultural growth in future.

The results of decomposition of agriculture growth reveal that, as at the national level, yield increase was the pre-dominant source of growth in agriculture in all the regions during 1980s, while during 1990s growth sources varied across regions (Table 5). For

example, it was the prices in the eastern and northern regions, and crop diversification in the southern and western regions that accounted for a large share in the growth of crop sector during 1990s. A brief account of growth sources in different regions is discussed below:

Table 5—Contribution of different sources of growth in the crop sector by region and period (percent)

Region	Period	Area	Yield	Prices	Diversification	Interaction	Total
Northern	1980s	1.4	75.4	-6.5	29.7	0.1	100.0
	1990s	10.1	16.6	44.0	28.2	1.1	100.0
Eastern	1980s	17.8	49.7	11.8	19.7	1.0	100.0
	1990s	-29.7	38.7	45.8	42.6	2.6	100.0
Western	1980s	11.6	36.5	7.3	39.0	5.5	100.0
	1990s	13.4	24.8	25.7	35.8	0.4	100.0
Southern	1980s	10.4	39.5	16.8	32.1	1.3	100.0
	1990s	-8.7	36.2	29.3	45.0	-1.8	100.0

Source: Authors' calculations based on data from various years of *Indian Agricultural Statistics* and *Value of Output of Crop Sector*.

NORTHERN REGION

The region is dominated by rice and wheat, which account for about 62.5 percent in the gross cropped area and about 56.2 percent in the gross value of crop output in TE 1999-2000 (Table 4). These were the main crops that experienced technological change and led the Green Revolution. Government policies were also favorable towards these crops in terms of assured prices and procurement. The next important commodity group in northern region is fruits and vegetables, which account for only 5 percent in the gross cropped area but contributes about 18.2 percent in the value of aggregate crop output during TE 1999-2000.

The growth of crop sector remained around 3.5 percent during 1980s and 1990s (Table 6). It was noted that during 1980s, growth in crop sector had a diversified base with rice and wheat each contributing nearly 25 percent to the growth that followed by fruits

and vegetables (18.2%) and sugarcane (12.4%). The scenario changed drastically during 1990s. The share of wheat in the growth of crop sector almost doubled (45.1%) and that of fruits and vegetables increased to 30.9 percent.

Table 6—Contribution of different crops in overall growth of crop sector in the northern region

Crops	Annual growth in the value of crop output (%)		Share in annual growth rate (%)	
	1980s	1990s	1980s	1990s
Rice	3.5	4.0	24.9	24.7
Wheat	2.7	4.8	23.0	45.1
Coarse cereals	-0.6	0.9	-0.1	1.0
Pulses	4.9	0.4	7.4	-0.6
Oilseeds	1.5	-3.2	4.6	-3.6
Fibers	10.2	-8.8	9.7	-7.0
Sugarcane	3.9	3.7	12.4	9.4
Beverage crops	2.1	-24.0	0.0	0.0
Fruits and vegetables	3.3	7.3	18.2	30.9
Spices	3.9	3.2	0.3	0.3
Others	-3	-1	-0.5	-0.3
Total	3.3	3.7	100.0	100.0

Source: Authors' calculations based on data from various years of *Value of Output of Crop Sector*.

Decomposition of crop income growth shows that during 1980s, the real prices of major commodities declined in the region but were well compensated for by (i) phenomenal rise in the yield levels of important crops, and (ii) crop diversification in favor of rice, wheat, sugarcane and fruits and vegetables (Table 6, and Appendix II). The situation changed dramatically during the decade of 1990s, when increase in the real prices of rice, wheat and sugarcane dominated in the value of crop output. Expansion in area and crop diversification towards rice and wheat continued but the pace slowed down. However, area expansion and crop diversification picked-up speed for fruits and vegetables due to their rising demand and easy access to growing market of Delhi. It appears that rice and wheat would continue to be important in the region as long as government policies favor these crops. Though rice and wheat contributed to achieve food security at the national

level, these commodities are also responsible for threatening the sustainability of soil and water resources of the region (Kumar et al 1998). The future growth opportunities in this region would rely on another technological breakthrough to augment yield of important crops, conserve soil and water resources, and promote agricultural diversification towards more remunerative commodities for processing and value-addition.

EASTERN REGION

Eastern region is dominated by rice, which shares about 59 percent in gross cropped area and 42 percent in the gross value of crop output in TE 1999-2000 (Table 4). Fruits and vegetables are next commodity group, which account for 11 percent in gross cropped area and 35 percent in gross value of crop output. The region experienced deceleration in the performance of crop sector; the growth declined from a robust 5.1 percent during 1980s to mere 1.9 percent during 1990s. It was noted that rice and fruits and vegetables were the major sources that contributed to growth during 1980s as well as 1990s (Table 7).

Table 7—Contribution of different crops in overall growth of crop sector in the eastern region

Crops	Annual growth in gross value of output (%)		Share in annual growth rate (%)	
	1980s	1990s	1980s	1990s
Rice	4.6	2.9	39.1	44.0
Wheat	1.5	5.3	1.8	9.5
Coarse cereals	-0.1	-0.3	0.3	-0.5
Pulses	4.8	-6.8	5.3	-10.9
Oilseeds	6.8	-7.4	4.8	-9.2
Fibers	1.1	-0.5	1.4	-0.1
Sugarcane	2.1	0.5	1	-0.5
Beverage crops	2.6	1.7	4.6	2.8
Fruits and vegetables	5.2	4.3	37.3	58.9
Spices	7.7	4.4	4.7	6.0
Others	0.0	-0.1	-0.1	-0.1
Total	5.1	1.9	100.0	100.0

Source: Authors' calculations based on data from various years of *Value of Output of Crop Sector*.

The high growth in crop sector during 1980s mainly came from rise in crop yields especially of rice (Table 5, Appendix III). The results of decomposition analysis revealed that yield increases alone accounted for about 50 percent of the growth in crop sector. Area expansion and diversification together contributed 38 percent to growth during 1980s. The situation changed during 1990s, when the region witnessed a declining trend in the contribution of area, indicating diversion of land from agricultural to non-agricultural uses. Similarly, contribution of yield to growth also declined during 1990s. Important sources of growth during 1990s were rise in real prices and diversification towards rice, wheat and fruits and vegetables. The region is heavily populated therefore diversion of agricultural land for non-agricultural purposes is obvious. But slowing down and/or stagnating yield levels of important commodities, which are already at a low level, is a matter of concern. The future growth in the region would stem from introduction of improved technologies

and/or further crop diversification towards such commodities that could tap the potential of available resources such as labor and water.

WESTERN REGION

Agriculture in this region is highly diversified with none of the crop or crop group contributing over 21 percent to the value of crop output in TE1999-2000 (Table 4). Coarse cereals dominated (24.2%) in gross cropped area while oilseeds contributed highest (20.9%) in the value of crop output in TE 1999-2000. Agriculture in the region grew at an annual rate of 3.0 percent during 1980s, which increased to 5.2 percent during 1990s (Table 8). Among commodities, oilseeds, pulses and fruits and vegetables had significantly contributed (76%) to the growth during 1980s (Appendix IV). During 1990s, production portfolio was more diversified and included wheat, pulses, oilseeds, cotton, sugarcane and fruits and vegetables, with contribution of about 82 percent to the growth in the crop sector.

Table 8—Contribution of different crops in overall growth of crop sector in the western region

Crops	Annual growth in value of output (%)		Share in annual growth rate (%)	
	1980s	1990s	1980s	1990s
Rice	0.6	1.7	5.1	4.5
Wheat	0.2	8.6	2.5	23.2
Coarse cereals	-0.2	0.4	-2.1	1.7
Pulses	5.0	4.7	14.9	8.7
Oilseeds	8.3	4.5	45.4	16.5
Fibers	0.3	5.8	3.7	6.4
Sugarcane	1.9	6.2	7.4	8.3
Beverage crops	0.0	0.0	0.0	0.0
Fruits and vegetables	4.3	9.3	16.0	25.1
Spices	10.2	8.5	5.4	5.0
Others	-3.2	3.9	1.7	0.5
Total	3.0	5.2	100.0	100.0

Source: Authors' calculations based on data from various years of *Value of Output of Crop Sector*.

It was observed that the contribution of fruits and vegetables, wheat and cotton had increased during the 1990s, while it had decelerated for pulses and oilseeds (Table 8).

Among different sources, crop diversification emerged as the dominant source of growth during 1980s as well as 1990s (Table 5, Appendix IV). Rise in yield of important crops also contributed substantially during 1980s, but their share declined during 1990s. On the other hand, the contribution of prices to agriculture growth jumped from 7.3 to 25.7 percent during this period. Interestingly, crop diversification and rising prices were mainly responsible for the growth in the crop sector during the latter period. It may be noted that production portfolio shifted towards oilseeds, pulses and fruits and vegetables during 1990s by substituting coarse cereals. The region had witnessed a transformation as a result of investment in watershed programs and incentives to adopt water-saving technologies, like drip and sprinkler irrigation. For instance, area under drip irrigation in Maharashtra state in this region increased from a mere 500 ha in 1980s to about 1 million ha in 2001-02. Besides, this region has aggressively launched programs to promote oilseeds, pulses and fruits and vegetables. Specifically, Maharashtra took a bold initiative towards fruits and vegetables in 1990 by linking the Government's 'Employment Guarantee Scheme' with horticulture. The scheme required beneficiaries to allocate a minimum of 0.2 ha land for horticulture that qualified them to get subsidized inputs, including planting material. As a result 95 percent of the incremental 1 million ha area was allocated to horticultural crops between 1990 and 2001. Further, central government's scheme of establishing Export Processing Zones especially for grapes and onions has helped producers to diversify towards these crops. The results of such initiative were

remarkable. The state of Maharashtra contributed about 20 and 70 percent of total exports of onion and grapes respectively in 2003-04. Such initiatives in the region had led to crop diversification and higher crop yields, which eventually contributed to agricultural growth.

SOUTHERN REGION

Rice is the main crop in this part of the country with 26.7 percent share in the value of crop output in TE1999-2000 (Table 4). Oilseeds, fruits and vegetables and spices are other important crops. Crop sector in this region grew at an annual rate of 3.4 percent during 1980s, but decelerated to 2.8 percent during 1990s (Table 9).

Yield increase remained an important source of growth in crop sector both during 1980s and 1990s, although its share in growth fell slightly during the latter period mainly due to deceleration in yield growth of rice and oilseeds (Table 5, Appendix V).

Diversification emerged as the main source of growth during 1990s with a share of 45 percent in the gross value of crop output. Fruits and vegetables, spices and beverages gained from land reallocation away from oilseeds, cotton, coarse cereals and pulses. It is interesting to note that during 1980s the diversification was more towards oilseeds (because of government policy of achieving self-sufficiency), and coarse cereals (because of their increasing demand especially of maize as feed in the poultry sector), which witnessed phenomenal growth during this period. The contribution of prices to agriculture growth too increased due to rise in the real prices mainly of rice. Further, as in the eastern region, a tendency of diversion of cropland towards non-agricultural purposes is also emerging in this region because of increasing population pressure. Greater emphasis on the watershed development in the region helped sustain crop yields and crop diversification

towards more remunerative crops. Institutional developments like contract farming and cooperatives in the region too have helped diversification towards high value export crops like gherkins (a variety of small cucumbers). This region enjoys monopoly in production and exports of gherkins (90% of total country's production and export). To promote exports, the Government of Karnataka has abolished the APMC (Agricultural Produce Marketing Committee) cess levied on gherkins. Similarly, to promote production of fruits and vegetables, a cooperative society (HOPCOMS: Horticultural Cooperative Marketing Society) in Karnataka is providing an assured output market and prices, input supplies and services. More such efforts are under progress to promote production and export of other fruits and vegetables in southern region.

Table 9—Contribution of different crops in overall growth of crop sector in the southern region

Crops	Annual growth in value of output (%)		Share in annual growth rate (%)	
	1980s	1990s	1980s	1990s
Rice	1.4	2.3	10.8	26.2
Wheat	-7.0	5.6	-0.5	0.5
Coarse cereals	-2.7	3.0	-5.1	6.1
Pulses	6.9	2.8	5.1	2.5
Oilseeds	4.3	-1.5	33.0	-5.6
Fibers	3.0	-3.3	5.3	-2.8
Sugarcane	6.1	6.4	7.9	16.0
Beverage crops	4.9	2.1	5.6	9.9
Fruits and vegetables	5.1	5.7	20.9	23.6
Spices	8.8	7.1	16.1	22.3
Others	5.1	12.9	0.8	1.3
Total	3.4	2.8	100.0	100.0

Source: Authors' calculations based on data from various years of *Value of Output of Crop Sector*

To sum up, the regional patterns of growth sources were quite varied. Yield increases had been the main source of agriculture growth during 1980s especially in rice and/or wheat dominated northern and eastern regions of the country. In the subsequent

decade, however, the price increases emerged as the major source of growth in northern and eastern regions. This is because of government policy of assured market for rice and wheat at minimum support prices, which were raised at a faster rate during 1990s to check the adverse effects of decelerating growth in crop yields on farm profitability. On the contrary, agriculture in the southern and western regions is largely rainfed and could not take advantage of high-yielding varieties of rice and wheat. These regions have followed diversification-led growth path compared to northern and eastern regions, which followed price-led growth during 1990s. A conducive production environment is building-up for fruits and vegetables and their processing in southern and western regions besides their growing demand in domestic and international markets. Therefore, future speed of agricultural diversification towards high-value and processed commodities will rely on how vertical linkages are strengthened through better supply chain management and value addition through processing.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The study examines the sources of growth in Indian agriculture for the decades of 1980s and 1990s. The analysis confirms that at the national level, technology (yield increases) was the prime mover of growth during 1980s, while rising prices and diversification emerged as the dominant source of growth in agriculture during 1990s. Diversification towards higher-value crops such as fruits and vegetables accounted for about 27% of crop income growth in the 1980s and 31% in the 1990s.

There is, however, substantial regional variation in the pattern of growth sources. In the grain-dominated northern and eastern regions, price increases were the most important

source of growth during 1990s, while in the more diversified southern and western regions crop income growth was led by diversification into higher-value crops.

Regional variation in the sources of growth was also observed in Vietnam. The contribution of diversification to crop income growth in the commercialized Southeast region of Vietnam near Ho Chi Minh City was 26%, while the contribution of diversification in the more subsistence-oriented Northern Upland region of Vietnam was just 6% (Minot, 2003).

As mentioned earlier, drawing policy implications from these trends is not always obvious and requires additional assumptions about the likely return from investments in strengthening each source of growth. With this in mind, we tentatively offer the following conclusions for policy. First, the declining contribution of yields to crop income growth should be viewed seriously. If yield growth were steady, the declining *relative* importance of yield growth to crop income growth would be less of a concern. However, the yield growth of major agricultural commodities has declined. Given the wealth of studies on the high rates of return to investment in agricultural research and development, it is likely that there continues to be under-investment in this area. This implies the need to (i) improve the efficiency of investment in agricultural research and development, and (ii) revisit the agenda for agricultural research and development keeping in view the opportunities and challenges in agriculture across different regions in India.

Second, the increasing contribution of diversification to agriculture growth indicates that greater attention must be devoted to this avenue for rural income growth. In particular, crop diversification offers an opportunity to augment income and employment

especially in the rainfed areas that were somewhat neglected during the Green Revolution period. Studies have reported that diversification towards high-value commodities augments income, generates employment opportunities, empowers women farmers and conserves natural resources (Pingali and Rosegrant 1995, Chand 1996 and Ryan and Spencer 2001). Crop diversification towards more remunerative commodities, thus, can serve as an effective tool to alleviate poverty, generate rural employment and conserve natural resources. This would require greater investment in extension services for high-value crops, market information systems, technology to address the perishability of many high-value crops, and facilitation of the institutional arrangement to enhance vertical coordination in these markets. Fruits and vegetables are an important component of the high-value agricultural sector, but not the only one.

Third, growth in output prices has served as an important source of agricultural growth. Some of this growth in output prices is related to higher government-set prices, particularly rice and wheat, but this is not sustainable in the long run. The higher prices for fruits and vegetables is largely caused by rising demand and higher quality (including some horticultural exports). Policy reforms and infrastructure improvements can also continue to contribute to higher farm-gate prices and, hence, rural income growth. On the other hand, these two factors can cut both ways – in some cases, market reform and improved infrastructure will introduce greater competition from agricultural commodities from outside the state or outside the country, benefiting consumers but not necessarily farmers. Also the price-led growth benefits the farmers in proportion to their marketable surplus. The smallholders generally gain less than medium- and large-scale farmers from

higher prices. Such a phenomenon may lead to growth but could widen the disparities between small and large farmers.

Fourth, area expansion may not continue to contribute to crop income growth in land-scarce regions. The sustainable and equitable agricultural growth in such regions would only arise through agricultural diversification towards more remunerative commodities and technological breakthroughs. It is pertinent to target these growth sources to achieve sustainable and equitable growth in agriculture.

The methods used in this study open up several avenues for further research. First, the decomposition of agricultural growth could be extended to a state-level or even district-level analysis⁹. Second, it might be possible to examine econometrically the impact of different policies and agro-climatic conditions on the composition of crop income growth over the two decades. Third, it would be useful to expand the analysis from the decomposition of crop income growth to the analysis of rural income growth, incorporating the effect of changes in rural income associated with income from livestock, fisheries, and non-farm activities.

⁹ While state-level data are available from the statistical yearbooks, compiling district-level data would be a more difficult task, as it would require obtaining data from each of the states in India.

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Appendix I: Growth rates of area, production, yield and real prices of major crops in India (%)

Crops	Area		Production		Yield		Price	
	1980s	1990s	1980s	1990s	1980s	1990s	1980s	1990s
Rice	0.5	0.4	4.0	1.8	3.5	1.4	-1.0	1.1
Wheat	0.3	1.7	3.0	3.6	3.0	1.9	-1.0	2.1
Coarse cereals	-1.5	-2.2	0.2	-0.3	1.7	1.9	-1.0	1.4
Pulses	-0.2	-0.6	1.1	0.4	1.3	1.0	4.1	1.5
Oilseeds	3.1	0.6	4.8	3.1	1.7	2.5	0.8	-2.4
Cotton	-0.9	1.5	3.7	1.3	4.6	-0.2	0.3	-1.7
Sugarcane	1.6	1.8	3.3	2.4	1.7	0.6	0.5	2.3
Beverage crops	1.0	1.1	2.7	2.7	1.7	1.6	0.4	-0.8
Fruits and vegetables	3.1	4.1	3.8	4.2	0.8	0.1	0.8	1.9
Spices	1.3	1.9	4.7	5.0	3.4	3.1	3.5	1.7

Source: Authors' calculations based on data from various years of *Indian Agricultural Statistics* and *Value of Output of Crop Sector*.

Appendix II: Decomposition of different sources of growth in the crop sector in the northern region (%)

	Area	Yield	Prices	Diversification	Interaction	All
During 1980s						
Rice	1.0	85.8	-20.6	33.5	0.4	100.0
Wheat	1.9	110.9	-38.5	26.7	-1.0	100.0
Coarse cereals	6.5	-3406.5	883.6	2382.8	233.6	100.0
Pulses	1.2	33.9	75.5	-14.9	4.2	100.0
Oilseeds	0.6	150.8	6.7	-50.3	-7.7	100.0
Fibers	1.7	67.7	-2.6	34.7	-1.4	100.0
Sugarcane	1.9	69.4	-4.9	33.0	0.6	100.0
Beverage crops	0.4	95.8	45.2	-57.3	15.8	100.0
Fruits and vegetables	1.0	-3.7	15.4	83.7	3.6	100.0
Spices	2.0	23.5	116.4	-25.4	-16.5	100.0
Others	2.1	-4.7	-85.3	189.7	-1.8	100.0
Total	1.4	75.4	-6.5	29.7	0.1	100.0
During 1990s						
Rice	8.3	25.6	36.9	27.6	1.6	100.0
Wheat	7.0	37.2	45.1	8.9	1.8	100.0
Coarse cereals	44.8	147.9	125.8	-219.7	1.3	100.0
Pulses	-87.9	-6.6	-208.0	406.4	-3.9	100.0
Oilseeds	-13.2	25.8	59.5	23.5	4.5	100.0
Fibers	-5.7	75.1	8.1	24.3	-1.8	100.0
Sugarcane	13.5	1.2	72.4	12.1	0.8	100.0
Beverage crops	-3.5	32.6	17.9	56.2	-3.1	100.0
Fruits and vegetables	5.6	-6.5	24.3	77.0	-0.5	100.0
Spices	11.5	22.1	77.7	-12.2	0.9	100.0
Others	-8.6	16.8	-16.0	107.7	0.1	100.0
Total	10.1	16.6	44.0	28.2	1.1	100.0

Source: Authors' calculations based on data from various years of *Indian Agricultural Statistics* and *Value of Output of Crop Sector*

Appendix III: Decomposition of different sources of growth in crop sector in the eastern region (%)

	Area	Yield	Prices	Diversification	Interaction	All
During 1980s						
Rice	18.9	94.8	-13.9	0.1	0.2	100.0
Wheat	61.3	100.5	-65.0	6.0	-2.8	100.0
Coarse cereals	81.0	371.5	-83.3	-251.6	-17.6	100.0
Pulses	20.4	16.8	71.6	-9.2	0.4	100.0
Oilseeds	20.1	38.5	17.0	21.5	2.8	100.0
Fibers	29.0	112.5	9.3	-48.6	-2.2	100.0
Sugarcane	39.6	122.1	-5.5	-54.6	-1.7	100.0
Beverage crops	18.9	25.5	52.3	1.1	2.2	100.0
Fruits and vegetables	12.7	5.3	24.8	55.2	2.0	100.0
Spices	10.9	7.5	53.0	26.3	2.2	100.0
Others	-16.3	-11.3	-6.3	132.1	1.9	100.0
Total	17.8	49.7	11.8	19.7	1.0	100.0
During 1990s						
Rice	-26.2	47.9	55.9	22.8	-0.4	100.0
Wheat	-15.5	35.4	48.8	30.9	0.4	100.0
Coarse cereals	108.3	-224.5	-51.3	268.1	-0.6	100.0
Pulses	12.7	16.1	-6.3	80.1	-2.6	100.0
Oilseeds	13.2	13.6	24.8	54.0	-5.5	100.0
Fibers	611.9	185.8	-243.7	-503.6	49.6	100.0
Sugarcane	113.6	112.2	-201.2	102.9	-27.6	100.0
Beverage crops	-46.7	77.8	15.2	52.6	1.1	100.0
Fruits and vegetables	-17.2	25.1	19.8	69.0	3.3	100.0
Spices	-17.1	-0.2	76.7	42.9	-2.3	100.0
Others	24.6	20.2	-51.0	106.2	0.1	100.0
Total	-29.7	38.7	45.8	42.6	2.6	100.0

Source: Authors' calculations based on data from various years of *Indian Agricultural Statistics* and *Value of Output of Crop Sector*

Appendix IV: Decomposition of different sources of growth in crop sector in the western region (%)

	Area	Yield	Prices	Diversification	Interaction	All
During 1980s						
Rice	21.9	122.1	-70.4	26.7	-0.2	100.0
Wheat	49.3	454.9	-177.9	-237.1	10.8	100.0
Coarse cereals	-81.7	-383.8	253.4	292.3	19.8	100.0
Pulses	10.0	9.4	68.0	0.7	11.9	100.0
Oilseeds	6.9	4.6	8.2	73.1	7.0	100.0
Fibers	12.5	148.8	12.2	-52.4	-21.1	100.0
Sugarcane	9.9	-1.6	0.6	89.6	1.4	100.0
Beverage crops	na	na	na	na	na	na
Fruits and vegetables	7.4	8.8	15.8	67.8	0.2	100.0
Spices	8.9	26.1	50.2	31.1	-16.2	100.0
Others	3.7	-51.6	67.0	-45.1	126.0	100.0
Total	11.6	36.5	7.3	39.0	5.5	100.0
During 1990s						
Rice	35.2	8.2	86.1	-25.4	-4.1	100.0
Wheat	7.0	23.0	30.2	36.9	2.8	100.0
Coarse cereals	99.6	91.6	327.1	-423.2	5.0	100.0
Pulses	18.1	37.9	42.5	-3.3	4.9	100.0
Oilseeds	18.3	49.0	-50.0	81.5	1.3	100.0
Fibers	13.2	69.9	-1.2	23.4	-5.4	100.0
Sugarcane	10.9	-1.6	39.6	49.9	1.2	100.0
Beverage crops	na	na	na	na	na	na
Fruits and vegetables	6.4	6.2	30.5	58.3	-1.4	100.0
Spices	6.7	26.0	36.3	30.0	1.0	100.0
Others	29.8	-203.1	223.1	95.4	-45.2	100.0
Total	13.4	24.8	25.7	35.8	0.4	100.0

Source: Authors' calculations based on data from various years of *Indian Agricultural Statistics* and *Value of Output of Crop Sector*.

na = not applicable. Beverage crop production data are not available for this region.

Appendix V: Decomposition of different sources of growth in crop sector in the southern region (%)

	Area	Yield	Prices	Diversification	Interaction	All
During 1980s						
Rice	23.6	181.9	-64.1	-43.1	1.7	100.0
Wheat	-2.7	18.9	16.3	71.1	-3.6	100.0
Coarse cereals	-11.0	-30.3	51.2	91.5	-1.3	100.0
Pulses	7.5	17.3	54.9	20.5	-0.2	100.0
Oilseeds	9.2	0.9	8.9	78.4	2.5	100.0
Fibers	8.6	110.1	-4.2	-6.1	-8.5	100.0
Sugarcane	10.3	15.6	-1.2	73.3	2.1	100.0
Beverage crops	6.0	28.7	51.2	12.0	2.2	100.0
Fruits and vegetables	5.9	16.7	39.9	37.7	-0.3	100.0
Spices	5.2	20.8	53.9	17.0	3.2	100.0
Others	22.5	198.2	131.3	-245.0	-7.0	100.0
Total	10.4	39.5	16.8	32.1	1.3	100.0
During 1990s						
Rice	-8.5	42.9	47.4	15.7	2.5	100.0
Wheat	-4.2	30.6	32.4	38.1	3.1	100.0
Coarse cereals	-7.6	58.8	50.4	0.0	-1.6	100.0
Pulses	-10.8	27.4	57.4	21.9	4.1	100.0
Oilseeds	36.6	-203.7	310.3	-69.1	25.9	100.0
Fibers	10.5	194.6	36.4	-155.4	13.9	100.0
Sugarcane	-4.2	23.1	31.9	47.5	1.7	100.0
Beverage crops	-3.2	37.9	32.7	30.7	1.9	100.0
Fruits and vegetables	-6.0	-12.4	54.1	68.7	-4.5	100.0
Spices	-3.6	42.6	38.4	22.4	0.3	100.0
Others	-13.7	44.0	69.7	8.1	-8.2	100.0
Total	-8.7	36.2	29.3	45.0	-1.8	100.0

Source: Authors' calculations based on data from various years of *Indian Agricultural Statistics* and *Value of Output of Crop Sector*

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